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SHORT COMMUNICATION

INSIGHTS INTO THE FUNCTIONAL POTENTIAL OF THE RICE WEEVIL ROSTRUM BASED ON MICROSTRUCTURE

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ABSTRACT

The structural differentiation of rostrum in male and female adults of rice weevil, *Sitophilus oryzae* was examined under the light and electron microscopes to understand its functional potential in infestation/ovipositional tactics. The microscopic observation revealed that, the length of the rostrum was remarkably longer and thinner for females than in males. This adaptation in females is highly specific to deposit and protect eggs inside the grains. With the help of well-defined mouthparts in the apex of the rostrum, weevils chew and swallow food through the tunnel in the rostrum. No remarkable segments or sensillae were observed in both male and female rostrums. The study also signified that, rostrum could be used as a morphological marker key in differentiating males and females in *S. oryzae* and this species nearly shares common morphological features of rostrum with *S. zeamais* and *S. granarius*.

Key words: *Sitophilus oryzae*, rice weevil, rostrum, insect pest, stored food products, SEM.

INTRODUCTION

Sitophilus oryzae L. is a weevil species belonging to the order Coleoptera and family Curculionidae. It is known to cause extensive loss to quality and quantity of stored grains as well as reduced viability of raw seeds. Specialization of mouthparts plays a significant role in insect pest species, presumably to act as an internal/external feeder on the host. In rice weevil *S. oryzae*, the adults possess well specialized and adapted rostrum which assist them in infesting host seeds/grains. The rostrum is a specialized structure in the weevil head, noted to be as a taxonomic morphological marker key. It is typically structured for producing holes on the host plant tissues or parts; specifically useful to enable females to deposit eggs in the holes produced. Rostrum dimorphism is an important feature in weevils, in which generally size, structure and functions are known to vary between males and females. Danforth and Asher (1999) denoted that adult females fulfill the ovipositor role by excavating and prepare oviposition sites with the use of rostrum. Adults possess mandibles and other mouthparts at the end of the rostrum, which is used for feeding and preparing holes. According to McKenna *et al.* (2009), most of the phytophagous weevils feed on nearly all plant taxa. Weevils specifically adapt to certain parts of plants due to internal and external specification in rostrum (Wilhelm *et al.* 2011). Curculionidae is the most dominant family with 62,000 known species world-wide in Coleoptera (Gahari *et al.* 2010). Similarly, among the stored product insects, Curculionidae has dominated other beetle families. For managing insect pests with an eco-friendly integrated pest management strategy, sound knowledge about insect biology, behavior and environmental factors are essential. Hence, we examined the structural variation of rostrum in male and female adults under light and electron microscopy to understand its functional potential in infestation/ovipositional tactics.

MATERIALS AND METHODS

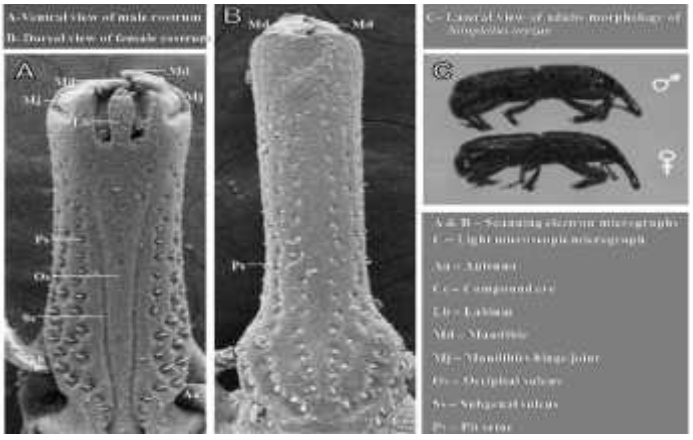
Adults of *S. oryzae* were obtained from the stock culture of insectary at CSIR-Central Food Technological Research Institute at Mysore, India. Obtained adults were separated by sex based on their morphological characteristics under a Magnus Stereomicroscope (4.5X). Mature and active weevils were selected for electron microscopic specimen preparation. Freshly collected male and female adults were killed in 95% alcohol and the rostrum disarticulated from head. The isolated rostrum was washed in alcohol in order to remove the impurities, and transferred to paraformaldehyde. After 12 h, specimens were fixed in solution containing 2% paraformaldehyde and 2.5% glutaraldehyde buffered with 0.1 M phosphate buffer at pH 7.4. Further the specimens were subjected to post fixation with 1% osmium teroxide in the same phosphate buffer by following Moon (2015) with few amendments. After fixation, specimens were washed several times with 0.1 M phosphate buffer. Then the specimens were dehydrated with ethanol series in ascending concentrations from 30% to 100% at regular intervals (1 h per concentration). Dehydration was repeated once more with 100% ethanol for one hour. The specimens were then transferred to hexamethyldisilazane and air dried at room temperature. Prepared samples were finally sputter-coated with gold and examined under LEO

Scanning Electron Microscope 435 VP (Leo Electron Microscopy Ltd., Cambridge, UK) at 15 kV.

RESULTS AND DISCUSSION

Electron microscopic structure of rostrum in *S. oryzae* was examined in male and female adults in this study. Figure 1 shows a ventral view of the male rostrum and dorsal view of female rostrum. In both male and female, rostrum structure (in shape) looked like an elongated floral bud dorsally and blunt ended spike ventrally. In general, rostrum scale is variable between different species in the Curculionidae. A wide range of rostral forms were reported in weevils ranging from smaller, to several times longer, than the body size. In the present study, it was observed that the rostrum was about one third scale in length and straight in its structure in comparison to the whole body in the phytophagous *S. oryzae* (Fig 1C). Predominantly, rostrum is more elongated in animal substance feeding taxa than plant substance feeding taxa (Palmer, 2010). When compared to the male, female rostrum was remarkably longer and thinner. Particularly, longer and thinner rostrum structure in the female is adapted to make a deep excavation for protecting eggs inside the grains. According to Suleiman *et al*. (2012), female *S. oryzae* chew and form hole in the grain to deposit eggs inside. Emerged larvae grow completely inside the grain and emerge as adult weevils. Length variation in rostrum of male and female adults is also known as one of the secondary sexual characters in many other species. It can be used to differentiate sex easily without analyzing the genitalia in *S. oryzae*. Similar rostrum length variation was observed recently in the closely related species i.e., *S. zeamais* (Moon, 2015) and *S. granarius* (Dinuta *et al.* 2009). Among weevil groups, the position of antennae is distinguished between different genus and species. In *Sitophilus* genus, antennae are positioned close to the base of the rostrum. Similarly, in *S. oryzae* antennal position was also observed while, in the genus *Arnoldibelus*, antennae are attached to the middle of rostrum (Legalov, 2010).

It was observed that rostrum structure of *S. oryzae* appears like tuff and is a mechanical organ, which is used to produce holes in grains. With the use of well-developed mandibles and other mouthparts positioned at the apex of rostrum (Fig 1), adults excavate a tunnel in grains for feeding and for egg laying. Both male and female have similar structures in their mouthparts. The apex of the rostrum shows two mandibles vertically with hinge joints (jaw-like structure) and labium in the mouthpart (Fig 1A). A few sharpened teeth like structures appear in the mandibles to grasp, crush or cut food. Recently, similar observation in *S. zeamais* was reported by Moon (2015). Under the light microscope, a tube-like structure was observed inside the rostrum. Chewed food material passes via the tunnel in the rostrum. In the ventral view of rostrum, occipital sulcus and sugenal sulcus are clearly visible in both sexes under the electron microscope. Some of the weevil species have segmentation and sensory hairs in the rostrum. In general, hair-like sensilla plays different functional roles in chemosensation, mechanoreception and others for detection of plant surface cues. For example, Martins *et al.* (2012) reported the presence of larger cylindrical trichoid sensilla on the rostrum of *Lissorhoptrus oryzophilus* (Coleoptera: Curculionidae). In *S. oryzae*, segments and sensory hairs were not observed in rostrum in the present study. So, it is evident that the rostrum in *S. oryzae* is not involved in perception of host plant cues. Numerous pits with setae were found over the surface of the rostrum in *S. oryzae*, which is commonly distributed over-all the body surface. It implies that there was no remarkable function of pits setae for rostrum. Recently, Davis (2011) described rostrum development and structure formation in *S. oryzae*. In addition to that, in this study, we have described the fine structure and functional characteristics of rostrum in males and females of *S. oryzae.* This study concludes that this species closely shares common morphological features of rostrum with *S. zeamais* and *S. granaris*.



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